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(12) United States Patent **(10) Patent No.:** **US 6,413,403 B1**
(15) Date of Patent: ***Jul. 2, 2002**

(14) Inventor: Lindquist et al.**(16) Assignee:** NuTool Inc., Milpitas, CA (US)**(17) Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 62 days.**(18) Description:** This patent is subject to a terminal disclaimer.**(19) Claims:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 539, 540, 541, 542, 543, 544, 545, 546, 547, 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729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 909, 910, 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1078, 1079, 1079, 1080, 1081, 1082, 1083, 1084, 1085, 1086, 1087, 1088, 1089, 1089, 1090, 1091, 1092, 1093, 1094, 1095, 1096, 1097, 1098, 1099, 1099, 1100, 1101, 1102, 1103, 1104, 1105, 1106, 1107, 1108, 1109, 1109, 1110, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1119, 1120, 1121, 1122, 1123, 1124, 1125, 1126, 1127, 1128, 1129, 1129, 1130, 1131, 1132, 1133, 1134, 1135, 1136, 1137, 1138, 1139, 1139, 1140, 1141, 1142, 1143, 1144, 1145, 1146, 1147, 1148, 1149, 1149, 1150, 1151, 1152, 1153, 1154, 1155, 1156, 1157, 1158, 1159, 1159, 1160, 1161, 1162, 1163, 1164, 1165, 1166, 1167, 1168, 1169, 1169, 1170, 1171, 1172, 1173, 1174, 1175, 1176, 1177, 1178, 1179, 1179, 1180, 1181, 1182, 1183, 1184, 1185, 1186, 1187, 1188, 1189, 1189, 1190, 1191, 1192, 1193, 1194, 1195, 1196, 1197, 1198, 1199, 1199, 1200, 1201, 1202, 1203, 1204, 1205, 1206, 1207, 1208, 1209, 1209, 1210, 1211, 1212, 1213, 1214, 1215, 1216, 1217, 1218, 1219, 1219, 1220, 1221, 1222, 1223, 1224, 1225, 1226, 1227, 1228, 1229, 1229, 1230, 1231, 1232, 1233, 1234, 1235, 1236, 1237, 1238, 1239, 1239, 1240, 1241, 1242, 1243, 1244, 1245, 1246, 1247, 1248, 1249, 1249, 1250, 1251, 1252, 1253, 1254, 1255, 1256, 1257, 1258, 1259, 1259, 1260, 1261, 1262, 1263, 1264, 1265, 1266, 1267, 1268, 1269, 1269, 1270, 1271, 1272, 1273, 1274, 1275, 1276, 1277, 1278, 1279, 1279, 1280, 1281, 1282, 1283, 1284, 1285, 1286, 1287, 1288, 1289, 1289, 1290, 1291, 1292, 1293, 1294, 1295, 1296, 1297, 1298, 1299, 1299, 1300, 1301, 1302, 1303, 1304, 1305, 1306, 1307, 1308, 1309, 1309, 1310, 1311, 1312, 1313, 1314, 1315, 1316, 1317, 1318, 1319, 1319, 1320, 1321, 1322, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1329, 1330, 1331, 1332, 1333, 1334, 1335, 1336, 1337, 1338, 1339, 1339, 1340, 1341, 1342, 1343, 1344, 1345, 1346, 1347, 1348, 1349, 1349, 1350, 1351, 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1359, 1359, 1360, 1361, 1362, 1363, 1364, 1365, 1366, 1367, 1368, 1369, 1369, 1370, 1371, 1372, 1373, 1374, 1375, 1376, 1377, 1378, 1379, 1379, 1380, 1381, 1382, 1383, 1384, 1385, 1386, 1387, 1388, 1389, 1389, 1390, 1391, 1392, 1393, 1394, 1395, 1396, 1397, 1398, 1399, 1399, 1400, 1401, 1402, 1403, 1404, 1405, 1406, 1407, 1408, 1409, 1409, 1410, 1411, 1412, 1413, 1414, 1415, 1416, 1417, 1418, 1419, 1419, 1420, 1421, 1422, 1423, 1424, 1425, 1426, 1427, 1428, 1429, 1429, 1430, 1431, 1432, 1433, 1434, 1435, 1436, 1437, 1438, 1439, 1439, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1448, 1449, 1449, 1450, 1451, 1452, 1453, 1454, 1455, 1456, 1457, 1458, 1459, 1459, 1460, 1461, 1462, 1463, 1464, 1465, 1466, 1467, 1468, 1469, 1469, 1470, 1471, 1472, 1473, 1474, 1475, 1476, 1477, 1478, 1479, 1479, 1480, 1481, 1482, 1483, 1484, 1485, 1486, 1487, 1488, 1489, 1489, 1490, 1491, 1492, 1493, 1494, 1495, 1496, 1497, 1498, 1499, 1499, 1500, 1501, 1502, 1503, 1504, 1505, 1506, 1507, 1508, 1509, 1509, 1510, 1511, 1512, 1513, 1514, 1515, 1516, 1517, 1518, 1519, 1519, 1520, 1521, 1522, 1523, 1524, 1525, 1526, 1527, 1528, 1529, 1529, 1530, 1531, 1532, 1533, 1534, 1535, 1536, 1537, 1538, 1539, 1539, 1540, 1541, 1542, 1543, 1544, 1545, 1546, 1547, 1548, 1549, 1549, 1550, 1551, 1552, 1553, 1554, 1555, 1556, 1557, 1558, 1559, 1559, 1560, 1561, 1562, 1563, 1564, 1565, 1566, 1567, 1568, 1569, 1569, 1570, 1571, 1572, 1573, 1574, 1575, 1576, 1577, 1578, 1579, 1579, 1580, 1581, 1582, 1583, 1584, 1585, 1586, 1587, 1588, 1589, 1589, 1590, 1591, 1592, 1593, 1594, 1595, 1596, 1597, 1598, 1599, 1599, 1600, 1601, 1602, 1603, 1604, 1605, 1606, 1607, 1608, 1609, 1609, 1610, 1611, 1612, 1613, 1614, 1615, 1616, 1617, 1618, 1619, 1619, 1620, 1621, 1622, 1623, 1624, 1625, 1626, 1627, 1628, 1629, 1629, 1630, 1631, 1632, 1633, 1634, 1635, 1636, 1637, 1638, 1639, 1639, 1640, 1641, 1642, 1643, 1644, 1645, 1646, 1647, 1648, 1649, 1649, 1650, 1651, 1652, 1653, 1654, 1655, 1656, 1657, 1658, 1659, 1659, 1660, 1661, 1662, 1663, 1664, 1665, 1666, 1667, 1668, 1669, 1669, 1670, 1671, 1672, 1673, 1674, 1675, 1676, 1677, 1678, 1679, 1679, 1680, 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Document ID	Page	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
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United States Patent [19] [11] Patent Number: 4,793,895
Kaanta et al.

[43] Date of Patent: Dec. 27, 1988

[54] IN SITU CONDUCTIVITY MONITORING
TECHNIQUE FOR
CHEMICAL/MECHANICAL
PLANARIZATION ENDPOINT DETECTION

[75] Inventor: Carter W. Kaanta, Cochituate,
Michael A. Lasek, Bristol, both of
Vt.

[73] Assignee: IBM Corporation, Armonk, N.Y.
[21] Appl. No.: 147,422.
[22] Filed: Jun. 25, 1988

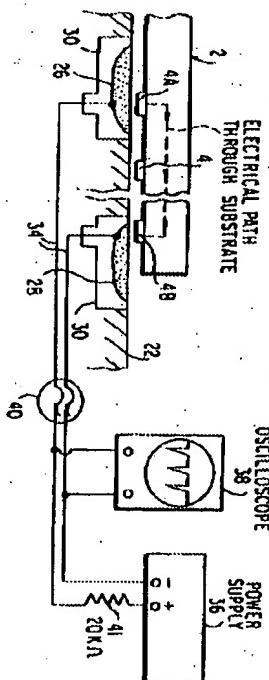
[51] Int. Cl.: H01L 21/00; H04C 1/22
[52] U.S. Cl.: 136/637; 156/645; 156/652; 156/656;
156/657; 156/658; 156/659; 156/662; 156/665; 156/676; 527; 636; 637;
156/633; 645; 682; 933; 945; 947/281 R; 317

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[18] Claims, 3 Drawing Sheets

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1976, by J. R. Stober, "Module Removal Tool".
Primary Examiner—William A. Powell
Assistant Agent or Firm—Sughrue, Mion, Zinn,
Macpeak & Sease

[57] ABSTRACT
An apparatus and method for monitoring the conductivity of a semiconductor wafer during the course of a polishing process. A polishing pad that contacts the water has an active electrode and at least one passive electrode, both of which are embedded in the polishing pad. A detecting device is connected to the active and passive electrodes for monitoring the current between the electrodes as the water is bopped by the polishing pad. The etch endpoint of the wafer is determined as a function of the magnitude of the current flow.



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Detailed Description Text - DENTX (5):

The fluid in cavity 140 can be a liquid or a gas and is introduced to cavity 140 via an inlet/outlet 146 which is connected through a pressure regulator 150 to a pressure supply 170.

The fluid in cavity 140 is preferably a liquid such as water if the machine 100 is desired for the polishing process.

The temperature control of the fluid in fluid cavity 140 is described in the related U.S. patent application Ser. No. 09/113,450, entitled "Temperature Regulation in a Process." A closed-loop controller 160 connected to regulator 150 selects a desired pressure for cavity 140 and pressure supply 170 and selectively operates as either a fluid source or a fluid sink to maintain the selected pressure. The pressure field of the fluid chamber can be constant or varied temporally or spatially with different locations of inlet/outlet 146.

Current US Original Classification - CCOR (1):

451/292

Current US Cross Reference Classification - CCXR (2):

451/293

United States Patent [19] [11] Patent Number: 6,126,527

[45] Date of Patent: Oct 3, 2000

Inventor: Shu-Hsin Kao, Redwood City, William F. Lepke, Santa Clara, all of Calif.

Assignee: Aiper Inc., Sunnyvale, Calif.

Filed: Jul 16, 1998

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Int. Cl.: B24B 21/30

U.S. Cl.: 431/367, 451/293, 451/303

Field of Search: 303/307, 384/124

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Document ID	Page	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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54	US 6126527 A	10	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
55	US 6121191 A	7	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	

planarizing surface is typically a planer pad made of a relatively soft, porous material such as blown polyurethane. The pad is usually mounted on a planar rotatable platen but linear moving pads are also now being proposed as described below.

Brief Summary Text - BSNTX (9):

During planarization it has been found that when a force is imposed on the action across the wafer is not uniform causing center-to-edge non uniformity in thickness and poor flatness of the wafer. The surface life of the planarizing pad is also a factor in affecting the planarity of the planarized wafer. Frictional heat generated at the wafer surface enhances the chemical action of the planarizing fluid and thus increases the planarization rate. The frictional heat however can cause planarity problems unless the heat is evenly transmitted over the surface of the wafer and typical planarizing systems utilize cooling systems to control the temperature of the planarization operation.

Brief Summary Text - BSNTX (10):

A number of attempts have been made in the prior art to improve the planarity of CMP operations. In U.S. Pat. No. 4,270,316 the uneven transmission of pressure which causes different degrees of abrasion of the planarized disks is compensated for by the provision of soft elastic inserts placed between a pressure piston and the back of the carrier plate on which the thin disk carrier is mounted. In U.S. Pat. No. 4,313,289 a deformable pressure plate so that the carrier can be deformed to either a concave shape or convex shape depending on the planarization required. In U.S. Pat. No. 4,910,155 a dam is provided on the planarizing plate so that the planarizing pool of slurry completely immerses the planarizing pad. In U.S. Pat. No. 4,918,869 the use of pressurized air acting on the pressure plate is provided so that the pressure on the wafer surface can be uniform. In U.S. Pat. No. 5,036,630 the wafer carrier comprises at least two (2) materials having different coefficients of

Brief Summary Text - BSNTX (11):

The above described CMP process was mainly directed to the methods typically used in the industry today which are basically termed a rotary or orbital polishing technique. The limitations of such rotary or orbital techniques are becoming increasingly evident since the wafer is inherently exposed to unequal radial velocities on its surface during polishing. These velocities which increase along the radius of the polishing platen and pad cause removal rates to vary across the wafer surface.

Brief Summary Text - BSNTX (12):

The next generation CMP process may be a non-rotary type technique now labeled Linear Planarization Technology (LPT). This technique uses a linear belt polish pad and eliminates the unequal radial velocities encountered during orbital or rotary polishing. Such techniques as shown in an article entitled "Linear Planarization Technology" published by Ontrak Systems, Inc. LAM Research

United States Patent	[19]	Patent Number:	6,129,610
Stephens	[45]	Date of Patent:	Oct. 10, 2000

[54] POLISH PRESSURE MODULATION IN CMP TO PREFERENTIALLY POLISH RAISED FEATURES

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[73] Assignee:

International Business Machines Corporation, Armonk, NY

[21] Appl. No.: [22] Filed: Aug. 14, 1998 [31] Int. Cl.: 451/43; 451/36; 451/35; [32] U.S. Cl.: 451/43; 451/36; 451/35; [33] Field of Search: 432,620, 164, 170, 285-290, 306, 307, [36] References Cited U.S. PATENT DOCUMENTS 4,270,316 Kretzschmar et al. 4,313,284 Walsh et al. 4,910,155 Cox et al. 4,918,869 Kim et al. 5,036,630 Schindler et al. 5,199,991 Kanam et al. 5,204,828 Kondo et al. 5,423,715 Shinkawa et al. 5,466,125 Saitoh et al. 5,522,965 Choi et al. Primary Examiner—Timothy V. Eley Attorney, Agent, or Firm—Delio & Peterson, LLC; John J. Tomaszewski ABSTRACT A chemical-mechanical planarization (CMP) process is provided whereby cyclical pressure means varies the force applied to the wafer and polishing pad during the planarizing operation with the polishing pad specially defined to have a relaxation time which is correlated with the force cycle so that the planarizing time is enhanced. The relaxation time of the pad is greater than the downward, as or upward, force cycle time on the wafer, at least, and provides a planarizing process wherein the height of the pad during planarization is intermediate between a decompressed pad position and a compressed pad position, typically occurring in a conventional CMP process. 8 Claims, 4 Drawing Sheets

Document ID	Page	1	2	3	4	5	6	7	8	9	10	S	C	2	Wind Codes	SON
33	US 6261151 B1	27	□	□	□	□	□	□	□	□	□	□	□	□	□	USPAT
34	US 6258205 B1	11	□	□	□	□	□	□	□	□	□	□	□	□	□	USPAT
35	US 6217430 B1	9	□	□	□	□	□	□	□	□	□	□	□	□	□	USPAT
36	US 6218852 B1	20	□	□	□	□	□	□	□	□	□	□	□	□	□	USPAT
37	US 6202169 B1	8	□	□	□	□	□	□	□	□	□	□	□	□	□	USPAT
38	US 6165056 A	20	□	□	□	□	□	□	□	□	□	□	□	□	□	USPAT
39	US 6146246 A	9	□	□	□	□	□	□	□	□	□	□	□	□	□	USPAT

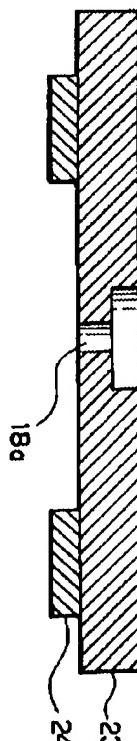


FIG. 10A

U.S. Patent Dec. 26, 2000 Sheet 10 of 13 6,165,056

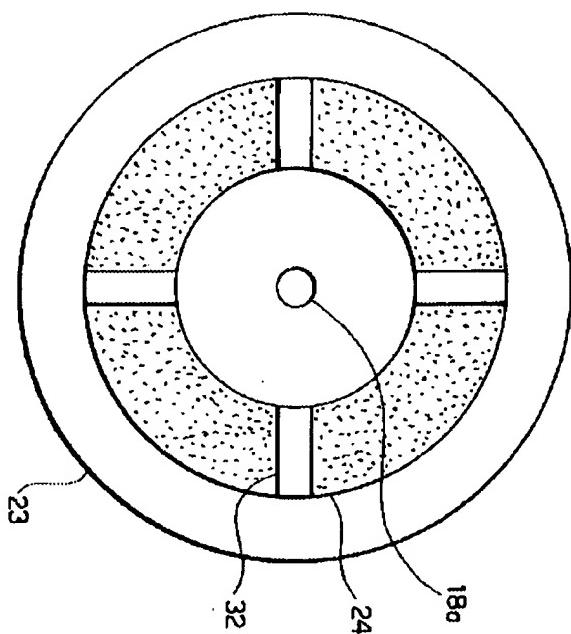


FIG. 10B

Detailed Description Text - BSTX (5):

In the coming of the information-oriented era, a ceaseless high demand for high-level electronic devices and appliances is huge. Especially, it is expected that the demand for personal computers will be greatest among various devices and appliances. It is considered that the semiconductor industry will shift to the next-generation wafer fabrication process with this trend. In the future, 300-mm wafers or 400-mm wafers will be introduced. There is an urgent demand for the development of CPM (chemical/mechanical polishing) equipment for flattening the surface layers of devices formed on such larger wafers. Furthermore, it is necessary to develop polishing machines capable of polishing such larger-size bare silicon wafers.

Brief Summary Text - BSTX (6):

It is considered that in CPM, the film thickness uniformity and surface flatness are the most important characteristics among quality characteristics. Namely, the flatness is the most important characteristic in bare silicon wafers.

Brief Summary Text - BSTX (7):

Where larger wafers are polished by the conventional polishing method, if polish slurry is supplied by the conventional method (namely, the slurry is supplied through a pipe which is attached outside the holder), it is difficult to make uniform the flow rate of polishing slurry across the total surface area of the wafer. Furthermore, even if wafer undulation or waviness cloth, it is practically difficult to form the undulation of the wafer surface.

Detailed Description Text - BSTX (93):

(5) The cost of the used slurry and polishing cloth accounts for a major portion of the running cost of the polish. When the slurry is discharged without being used for the polishing of the substrate. In the present invention, the slurry is compressed between the polishing cloth and the substrate through a spindle. Consequently, the slurry is used at a high efficiency for the polishing of the wafer. Since the total surface of the polishing cloth touches the substrate, the whole surface of the polishing cloth is used uniformly. Hence, the cloth is not wasted.

Current US Original Classification - CCOP (1):

Document ID	Page	1	2	3	4	5	6	7	Kind Codes	Comments
18 US 5304609 A	55	C	C	C	C	C	C	C	USPAT	
19 US 5099792 A	11	C	C	C	C	C	C	C	USPAT	
20 US 5893796 A	32	C	C	C	C	C	C	C	USPAT	
21 US 5876265 A	73	C	C	C	C	C	C	C	USPAT	
22 US 5308438 A	6	C	C	C	C	C	C	C	USPAT	
23 US 5265378 A	6	C	C	C	C	C	C	C	USPAT	
24 US 5245794 A	11	C	C	C	C	C	C	C	USPAT	

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